ＵＮＳＣＥＡＲ2020 年報告書【抜粋】

本資料は『UNSCEAR 2020 Report SCIENTIFIC ANNEX B: Levels and effects of radiation exposure due to the accident at the Fukushima Daiichi Nuclear Power Station: implications of information published since the UNSCEAR 2013 Report』を抜粋したものです。

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measurements of the radionuclides in the environment, for example, in air, on the ground, in foodstuffs and drinking water; *(c)* measurements of radionuclides in people, in particular, their thyroids and whole-body; *(d)* extensive personal dosimetry campaigns in a number of municipalities to measure external doses for people with different habits; and *(e)* various assessments, published in the peer reviewed literature by Japanese and other researchers, of doses to people from one or other exposure pathway.

178. In updating its dose assessment, the Committee has chosen to rely, to the extent possible, on measurements of radiation or radioactive material in people and/or the environment. In some cases, such measurements have been used, almost directly, as the basis of the dose estimates in this report; in others, the measurements have been used to validate models developed for the purposes of estimating doses to the wider population. The use of models (e.g., M2020) validated by local radiation measurements, including human measurements, has improved the reliability and reduced the uncertainty of the dose estimates.

179. The main changes and/or improvements in the approach adopted by the Committee and their implications are:

(a) An improved source term (based on the totality of measurements in the environment, correlated with the main events on the FDNPS site and taking account of the three chemical forms in which radioiodine was released) was used, together with improved ATDM, to estimate the concentrations of radionuclides in air for which only limited measurements were available; this resulted in a different spatial and temporal pattern of concentrations of radionuclides in air, with increases in air concentrations (and doses) at some location and decreases at others;

(b) A new empirical and validated model was developed to estimate external doses from radionuclides deposited on the ground based on extensive measurements of the variation of dose rate with time in Japanese conditions (e.g., soil types, climate); this generally resulted in an increase in estimated external doses, typically by several tens of per cent, compared with the UNSCEAR 2013 Report [U10], and a slower decrease in the dose rates with time;

(c) A biokinetic model was developed, specific to the Japanese population, whose diet is generally iodine-rich, to make more realistic estimates of doses from intakes of radioiodine by inhalation or ingestion; this resulted in a decrease in the estimated thyroid doses by a factor of about two compared with the UNSCEAR 2013 Report;

(d) Greater realism was incorporated into the modelling of various factors used in estimating doses (e.g., air filtration when inside different types of buildings, habits and behaviours, etc.) to take account of Japanese specific information. By far the most significant change, compared with the UNSCEAR 2013 Report, was making an allowance for the filtration of air afforded by buildings; as a result, estimates of doses from the inhalation of radionuclides decreased by a factor of about two;

(e) Much more realistic estimates of doses from the ingestion of food and drinking water were made based on better information about what members of the public actually bought and consumed, including from duplicate-diet and market-basket studies. Over the longer-term, an empirical model was used, based on measurements over 45 years of radiocaesium in food products and the whole diet in Japan from fallout from atmospheric nuclear weapons testing. These changes have reduced the estimates of doses from ingestion of food and drinking water by at least a factor of ten compared with the UNSCEAR 2013 Report.

180. Taken together, the effect of these changes has been revised estimates of municipality- and prefecture-average doses at the upper end of the ranges that are up to a few tens of per cent lower compared with those presented in the UNSCEAR 2013 Report [U10] for effective doses in the first year,

Table A11. Ranges of estimated municipality- or prefecture-average absorbed doses to the thyroid in the first year following the accident for residents of Japan for locations that were not evacuated

Geographical area	*Ranges of absorbed dose to thyroid*[a,b] *(mGy)*								
	Adult[c]			*10-year-old*			*1-year-old*		
	External + inhalation	*Ingestion*[d]	*Total*	*External + inhalation*	*Ingestion*[d]	*Total*	*External + inhalation*	*Ingestion*[d]	*Total*
Group 2[e] – Fukushima Prefecture									
Municipalities not evacuated	0.051–10	0.43	0.48–11	0.061–16	0.95	1.0–17	0.070–20	1.1	1.2–21
Group 3[f] – neighbouring prefectures									
Ibaraki Prefecture	0.22–2.0	0.11	0.33–2.2	0.30–3.0	0.25	0.55–3.2	0.35–3.5	0.31	0.66–3.9
Miyagi Prefecture	0.39–3.2	0.11	0.50–3.3	0.55–4.9	0.25	0.80–5.2	0.64–6.0	0.31	1.0–6.3
Tochigi Prefecture	0.30–1.2	0.11	0.41–1.3	0.35–1.4	0.25	0.60–1.7	0.40–1.7	0.31	0.72–2.0
Yamagata Prefecture	0.20–0.90	0.11	0.31–1.0	0.26–1.4	0.25	0.52–1.7	0.31–1.6	0.31	0.62–1.9
Group 4[g] – rest of Japan									
42 remaining prefectures	0.0[h]–0.45	0.034	0.034–0.48	0.0[h]–0.56	0.073	0.073–0.63	0.0[h]–0.65	0.087	0.087–0.74

[a] The reported doses are the ranges of the municipality-average doses for the Group 2 and Group 3 prefectures and the prefecture-average doses for the Group 4 prefectures. These estimates of dose are intended to be characteristic of the average doses received by people living at different locations and do not reflect the ranges of doses received by individuals within the population at these locations.

[b] Detailed estimates are not tabulated here for doses to the fetus but can be found in attachment A-14. Ranges of average fetal absorbed doses to the thyroid over the 30-week development period of the fetus are about 70% to 80% of the tabulated adult thyroid doses.

[c] Adult indoor workers have been considered to be representative of adults.

[d] Doses to a subgroup of the population (agricultural workers) who preferentially consumed local vegetables may be larger by a factor of about 3.

[e] Group 2: Members of the public living in the non-evacuated municipalities of Fukushima Prefecture.

[f] Group 3: Members of the public living in the prefectures of Ibaraki, Miyagi, Tochigi and Yamagata. These prefectures were grouped together to calculate the dose from ingestion in these prefectures.

[g] Group 4: Members of the public living in the remaining prefectures of Japan, including the previous Group 3 prefectures of Chiba, Gunma and Iwate.

[h] Estimated doses that are less than 1 µGy have been assigned a value of 0.0.

Figure A-VI. Estimated average absorbed dose to the thyroid in the first year to infants in each municipality of Fukushima Prefecture apart from those that were evacuated

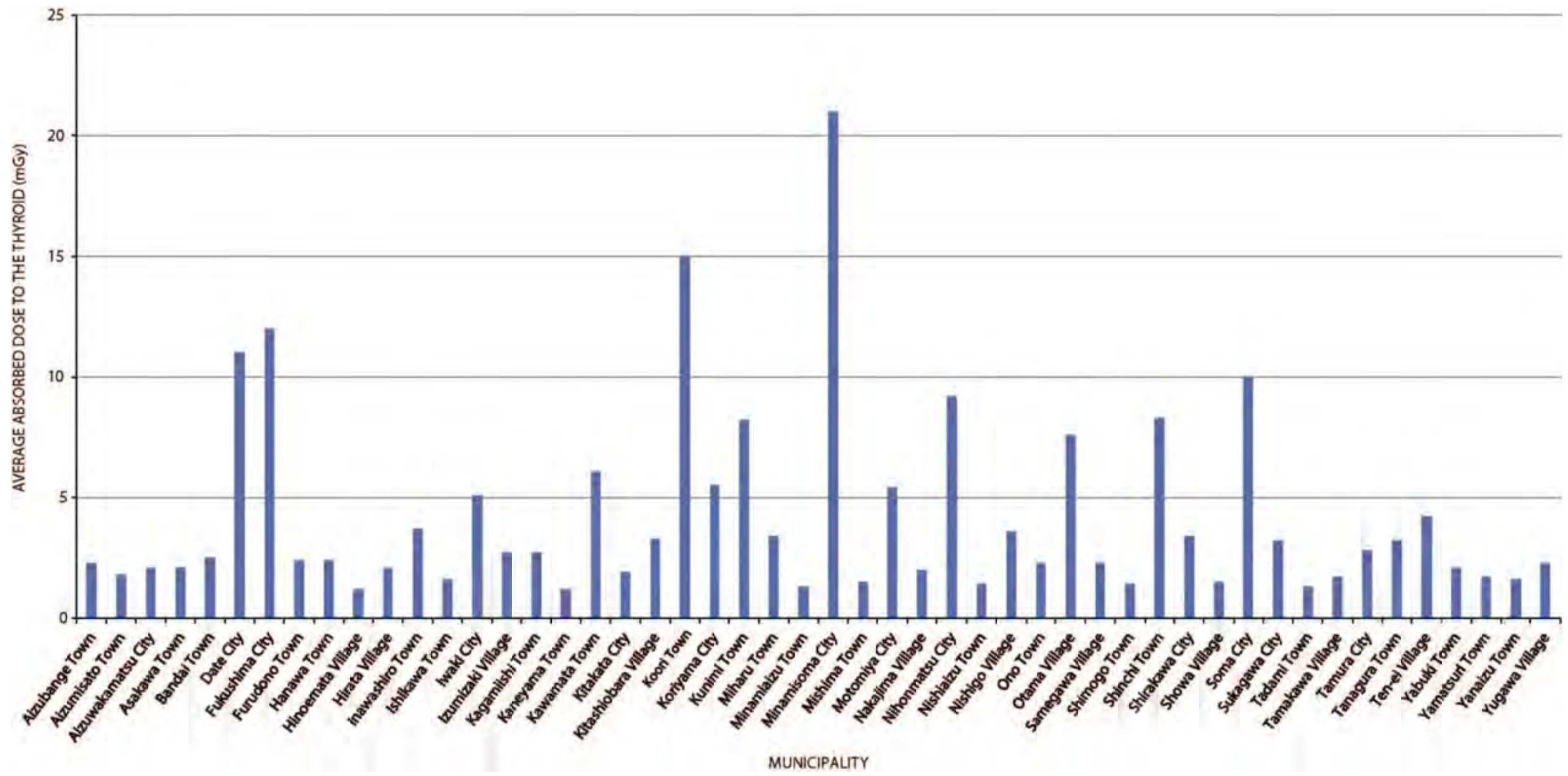


Table A12. Estimated effective doses to adults evacuated from municipalities of Fukushima Prefecture

The doses calculated are effective doses for each evacuation scenario, before and during evacuation, and for the first year following the accident. The dose estimates are intended to be characteristic of the average effective doses received by groups of people evacuated from each locality. The 95th percentile indicates the upper bound of the distribution of individual doses

Locality	*Scenario No.*	*Destination*	*Effective dose to adults (mSv)*					
			Evacuation[a]	*Destination*[b]	*Total first year*[c]		*Projected*[d]	*Averted*[e]
			Mean	*Mean*	*Mean*	*95th percentile*		
Futaba	01(FT1)	Saitama City	0.27	0.084	0.35	1.1	43	43
Futaba	02(FT2)	Ibaraki Prefecture	0.50	0.29	0.79	2.0	43	43
Futaba	03(FT3)	Ibaraki Prefecture	0.30	0.29	0.58	1.4	43	43
Futaba	04(FT4)	Koriyama City	0.56	1.9	2.5	4.3	43	41
Futaba	05(FT5)	Tochigi Prefecture	0.078	0.53	0.61	1.0	43	43
Kawauchi	06(TM1)	Niigata City	0.041	0.005	0.046	0.072	1.6	1.5
Tomioka	07(TM2)	Chiba City	0.25	0.25	0.50	1.1	18	17
Tomioka	08(TM3)	Chiba City	0.13	0.25	0.38	0.67	18	17
Tomioka	09(TM4)	Iwaki City	0.39	0.39	0.77	1.8	18	17
Naraha	10(NR1)	Nasushiobara City	0.14	0.64	0.78	1.3	2.7	1.9
Naraha	11(NR2)	Chiba City	0.22	0.25	0.47	0.97	2.7	2.2
Naraha	12(NR3)	Iwaki City	0.39	0.39	0.77	1.8	2.7	1.9
Naraha	13(NR4)	Tochigi Prefecture	0.069	0.53	0.60	1.0	2.7	2.1
Naraha	14(NR5)	Iwaki City	0.27	0.39	0.66	1.4	2.7	2.0
Okuma	15(OK1)	Aizuwakamatsu City	0.32	0.33	0.65	1.5	37	37
Okuma	16(OK2)	Tamura City	0.34	0.46	0.80	1.7	37	37

Locality	*Scenario No.*	*Destination*	*Effective dose to adults (mSv)*					
			Evacuation[a]	*Destination*[b]	*Total first year*[c]		*Projected*[d]	*Averted*[e]
			Mean	*Mean*	*Mean*	*95th percentile*		
Okuma	17(OK3)	Shinjuku Ward	0.23	0.10	0.33	0.86	43	43
Okuma	18(OK4)	Tamura City	0.71	0.46	1.2	3.2	0.64	–
Odaka	19(OK5)	Nasushiobara City	0.30	0.64	0.94	1.7	2.2	1.3
Namie	20(NM1)	Shinjuku Ward	0.15	0.10	0.25	0.57	16	16
Namie	21(NM2)	Soma City	0.44	0.69	1.1	2.3	16	15
Namie	22(NM3)	Koriyama City	0.34	1.9	2.3	3.8	16	14
Tsushima	23(NM4)	Nihonmatsu City	0.85	2.3	3.1	5.7	16	13
Namie	24(NM5)	Yonezawa City	0.31	0.058	0.37	1.3	16	16
Iitate	25(IT1)	Koriyama City	0.64	1.9	2.6	4.5	12	10
Iitate	26(IT2)	Aizu Region	0.083	0.33	0.41	0.68	12	12
Iitate	27(IT3)	Saitama City	0.28	0.084	0.36	0.99	12	12
Iitate	28(IT4)	Iitate Village	3.6	1.9	5.5	9.1	12	6.6
Odaka	29(OD1)	Shinjuku Ward	1.0	0.10	1.1	3.9	2.2	1.1
Odaka	30(OD2)	Tsuruoka City	0.027	0.078	0.11	0.18	2.2	2.1
Haramachi	31(OD3)	Yokohama City	0.17	0.054	0.22	0.58	2.3	2.1
Odaka	32(OD4)	Shinjuku Ward	0.61	0.10	0.72	2.3	2.2	1.5
Odaka	33(OD5)	Saitama City	0.43	0.084	0.52	1.6	2.2	1.7
Haramachi	34(HK1)	Yokohama City	0.26	0.054	0.31	0.91	2.3	2.0
Iitate	35(HK2)	Yamagata City	0.13	0.078	0.21	0.44	12	12
Kashima	36(HK3)	Yokohama City	0.54	0.52	1.1	2.4	1.6	0.55

Locality	Scenario No.	Destination	Effective dose to adults (mSv)					
			Evacuation[a]	Destination[b]	Total first year[c]		Projected[d]	Averted[e]
			Mean	Mean	Mean	95th percentile		
Haramachi	37(HK4)	Soma City	0.55	0.69	1.2	2.7	2.3	1.1
Hirono Town	10 (old)	Ono Town Office	0.46	0.30	0.75	2.1	1.9	1.2
Katsurao Village	12 (old)	Azuma Gymnasium	0.17	2.7	2.9	4.8	7.4	4.5
Katsurao Village	14 (old)	Azuma Gymnasium	1.2	2.7	3.9	7.4	7.4	3.5

[a] The effective dose for the evacuation is an estimate of the dose that people received before and during evacuation.

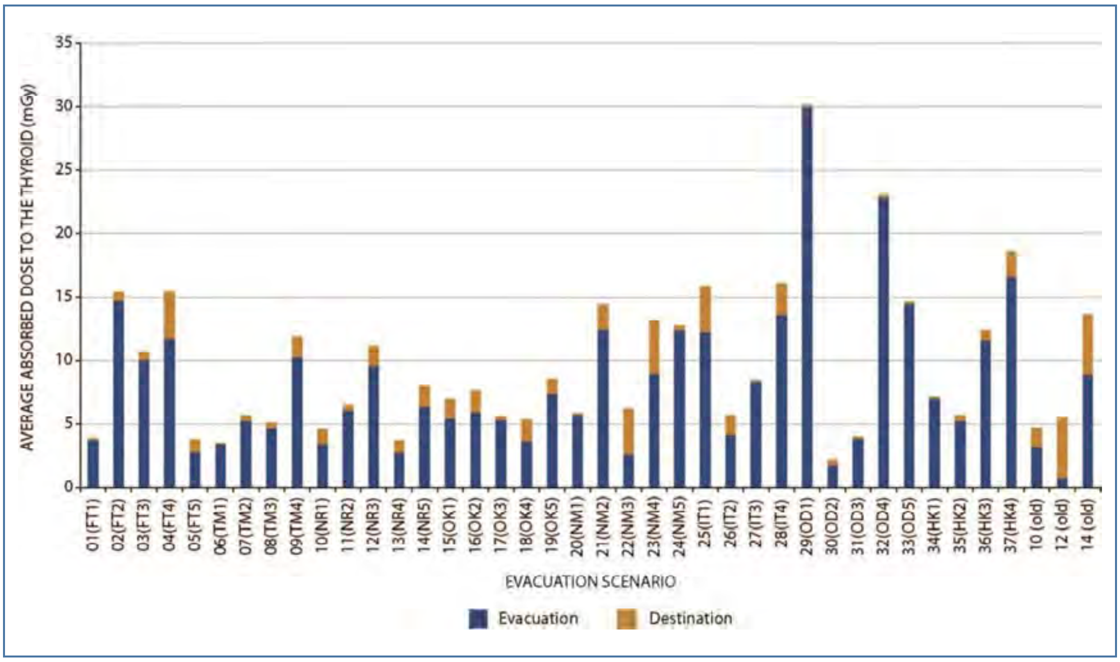
[b] The effective dose at destination is an estimate of the dose that people received for the remainder of the first year following evacuation.

[c] The total first-year effective dose is an estimate of the dose in the first year that people received before and during evacuation and at destination for the remainder of the year.

[d] The effective dose that is projected is an estimate of the dose that people would have received in the first year if they had not been evacuated.

[e] The effective dose that is averted is an estimate of the dose that people avoided by being evacuated. In some cases, this can be estimated to be a small negative value, because of the assumption that people were outdoors during the passage of the plume of radioactive material during evacuation, but would have been indoors if not evacuated. These cases are indicated by "–".

Figure A-IX. Average absorbed dose to the thyroid in the first year to infants for each evacuation scenario



A110. Figure A-IX shows the average absorbed dose to the thyroid for infants in the first year for each of the evacuation scenarios, with the contribution of the dose for the period of the evacuation and the dose at the destination separately indicated. For the absorbed dose to the thyroid, much more of the total in the first year was contributed by the period before and during the evacuation than was the case for the effective dose. Detailed results of the estimates of average absorbed dose to the thyroid of the evacuees are provided in attachment A-18. The protective effect of iodine blocking possibly implemented by some residents was not taken into account in the assessment. However, the general iodine-rich diet of the Japanese people has been reflected in the dose coefficients used.

A111. Comparisons with the doses to evacuees estimated in the UNSCEAR 2013 Report [U10] indicate that the Committee's revised estimates of average effective doses in the first year are about a few tens of per cent lower, but that the revised estimates of absorbed dose to the thyroid in the first year are between three and four times lower. This reduction is largely a reflection of the lower Japan-specific dose coefficients for intakes of radioiodine and the much lower destination doses from ingestion.

A112. The evacuation of municipalities was estimated, on average, to have averted effective doses to adults of up to about 40 mSv and absorbed doses to the thyroid of infants of up to about 500 mGy. In several scenarios, the average doses estimated to have been received by the evacuees were similar to those estimated to have been received had they stayed in place.

A113. For the small number of hospital and nursing-home patients, residents and other individuals in the 20-km zone for whom the 40 evacuation scenarios were not applicable, higher doses could not be ruled out. The doses that were averted, when added to the estimates of dose received before and during the evacuation, can be used as estimates of the doses to people who might have stayed in the evacuation zone, and as an upper bound for any individual who might have gained long term access to the zone.